2-2015

Engaging Teenagers with Science through Comics

Judy Diamond
University of Nebraska - Lincoln, jdiamond1@unl.edu

Abstract for DBER Group Discussion on 2015-02-05

Presenter(s), Department(s):
Judy Diamond
Professor & Curator
University of Nebraska State Museum

Title:
Engaging Teenagers with Science through Comics

Abstract:
Graphic novels or comics are powerful tools to motivate youth to become interested in science. Embedding science concepts into a story with graphics that appeal to teen culture makes abstract content approachable, stimulates youth interest, and promotes learning. This presentation will discuss the goals of the NIH-funded World of Viruses and Biology of Human comic series and the research results that support using these approaches.

science education outreach

broader impacts

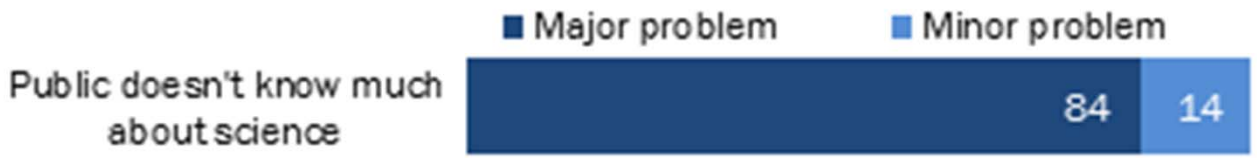
informal science education

non-formal education

informal science places (AAAS)

Scientists' Perspective: Limited Public Knowledge About Science Is a Major Problem

% of AAAS scientists saying... is a major or minor problem for science in general



AAAS scientists survey Sept 11-Oct 13, 2014. Q5d. Those saying this is not a problem or giving no answer are not shown.

PEW RESEARCH CENTER

formal education

teacher professional development

curriculum development

next generation science standards

common core

classroom presentations

hands-on science

students

grades, tests, graduation

prescribed duration

informal education

free-choice learning

families, youth

STEAM

mediated within a social context

can’t fail – no performance measures

self-directed

instantaneous to life-long

APE: active prolonged engagement

* can occur in formal settings

Bridging the gap between formal & informal science:

- increases student motivation for learning
- expands student conceptions of learning and knowledge
- develops new student skills and abilities

Orna Fallik, Sherman Rosenfeld and Bat-Sheva Eylon. 2013. School and out-of-school science: a model for bridging the gap. *Studies in Science Education*, 49 (1): 69–91.

Table 2. A comparison of the organisational aspect of formal and informal learning contexts.

Categories	Formal education	Informal education
Time of activity	Activity usually occurs during school hours	Activity usually occurs during after-school hours
Ultimate purpose	The ultimate purpose of the activity involves preparation for some future activity or work	The ultimate purpose of the activity is participation in the activity
Relationship between learner and teacher/ guide	A hierarchical relationship exists between the teacher and their students. As a result, teachers and students are expected to behave within the bounds of normative behaviour within the school framework	A symmetrical, non-hierarchical relationship exists between the guide and the students. As a result, there is more flexibility involved in the relationships between the guide and students
Orientation	The orientation focuses on acquiring academic knowledge and developing intellectual skills	The orientation does not focus only on academic knowledge and intellectual skills but provides opportunities to develop other types of knowledge and skills (e.g. social, creative, practical)
Evaluation	The emphasis is on providing formal grades for each individual student	The emphasis is providing mutual feedback

Orna Fallik, Sherman Rosenfeld and Bat-Sheva Eylon. 2013. School and out-of-school science: a model for bridging the gap. *Studies in Science Education*, 49 (1): 69–91.

informal science outreach

science festivals facebook twitter comic movie

theater planetarium program zoo natural history museum

science center nature centers afterschool programs

club TV apps multimedia exhibit

Internet exhibit cartoons uTube storytelling radio

podcast photo library IMAX film literacy program

contest afternoon with a scientist popular science book

product label blog Web site music rap

travel/ roads scholar tour nature walk newspaper article

magazine aquaria youth leader professional development

Diamond, McQuillan, Wood, C. 2012. **Biology of Human. NIH-SEPA**. 5 yrs. $1,334,000.

Shen, Diamond, Evans, Horn. 2010**. Life on Earth. NSF**. 3 years. $2,312,149.

Diamond, Rankin, Wood, C. 2007. **World of Viruses. NIH-SEPA**. 5 yrs. $1,617,788.

Diamond, Angeletti, Struthers. 2008. **Omaha Science Media Project. Sherwood**. 2 yrs. $1,877, 803.

MacDonald, Diamond, Uttal. D. 2007**. Understanding the Tree of Life. NSF**. 3 yrs. $250,000.

Farrell, Diamond, Dahlman, L. 2006. **Engaging Antarctica. NSF**. 3 yrs. $1.17 million.

Diamond. 2003. **Explore Evolution. NSF**. 3 years. $2.8 million.

Diamond and Heusel. 2000**. Wonderwise 4-H. NSF**. 3 years. $830,325.

Diamond. 1997. **Wonderwise On-Line. HHMI**. 4 years. $325,000.

Kean, Lewis, Christensen, Diamond, Scofield. 1994. **Statewide Systemic Initiative. NSF**. 4 yrs. $5.3 million

Diamond. 1992. **Science Museum in the Classroom. HHMI**. 5 years. $500,000.

Diamond. 1992. **Mesozoic Monsters, Mammals, and Magnolias. NSF**. 3 years. $386,404.

Diamond. 1988**. Interactive Mineral Exhibits. NSF**. 3 years. $190,000.

Biology of Human / World of Viruses

http://biologyofhuman.unl.edu

The *Biology of Human* project was funded by the National Institutes of Health (NIH) through the Science Education Partnership Award (SEPA) Grant No. R25OD010506. Its content is solely the responsibility of the authors and does not necessarily represent the official views of the NIH. Principal investigators are Judy Diamond Ph.D., University of Nebraska State Museum, Julia McQuillan Ph.D., Department of Sociology at the University of Nebraska (UNL), and Charles Wood Ph.D., the Nebraska Center for Virology.

Performance disparities in mathematics and science are evident among different demographic groups at grades K, 4, and 8.

Low-income families had lower mathematics and science scores than their peers from more advantaged backgrounds.

Black, Hispanic, and American Indian or Alaska Native students performed substantially lower than their white and Asian or Pacific Islander counterparts.

Sex differences in achievement were generally small and favored boys in most cases. Among black students, however, girls performed better.

Some gaps in science narrowed somewhat from 2009 to 2011. The white-black gap decreased from 36 to 34 points. The white-Hispanic gap fell from 30 to 26 points. The gap between low- and high-performing students dropped from 89 to 87 points.

Science and Engineering Indicators 2014. National Science Foundation. National Center for Science and Engineering Statistics. Arlington VA.

A collaboration of the

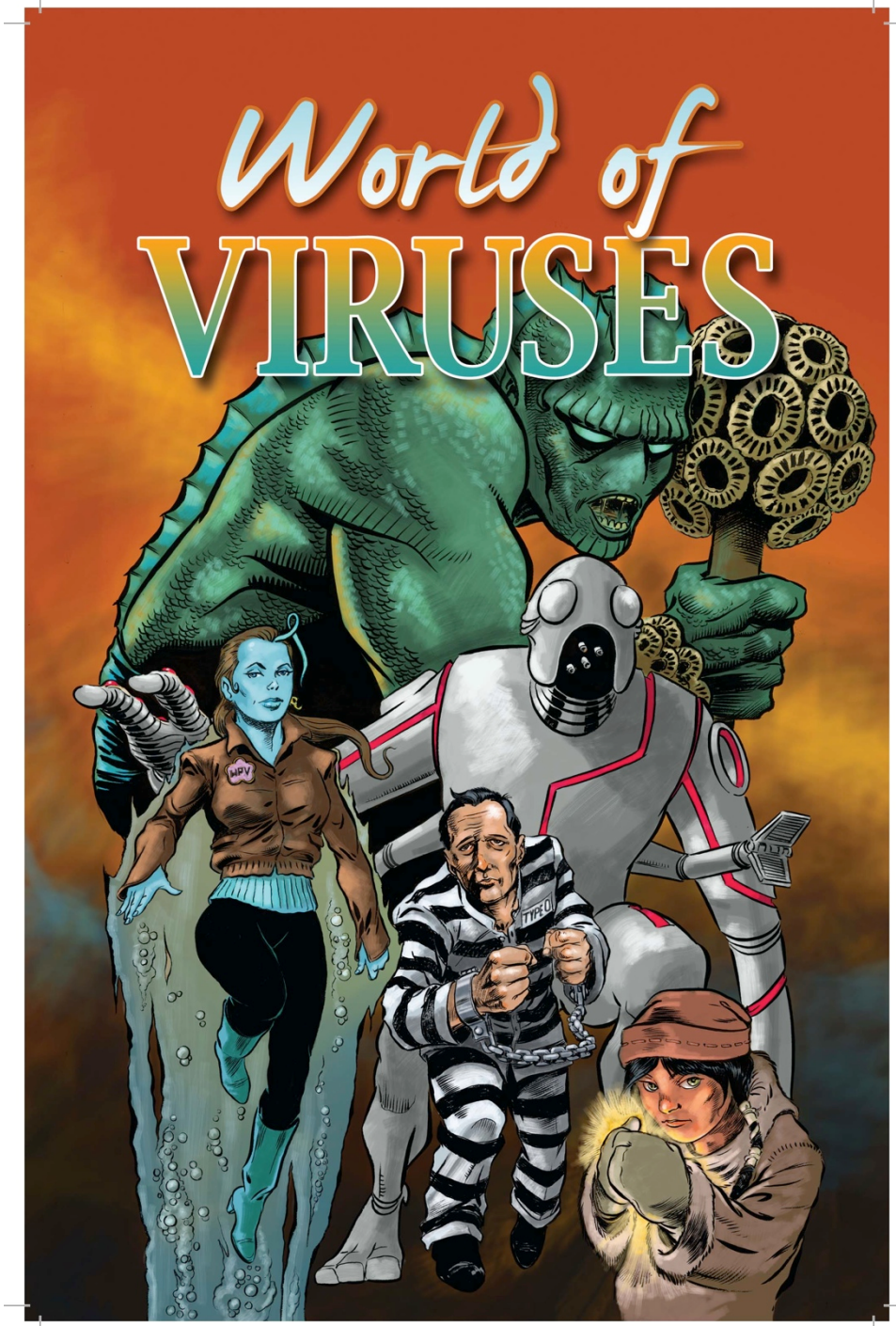
University of Nebraska State Museum

Nebraska Center for Virology

Department of Sociology at University of Nebraska – Lincoln

Carl Zimmer 2012. *A Planet of Viruses*. University of Chicago Press.
Revised new edition coming in 2015.


Human Papilloma Virus
HIV/AIDS
Vaccines



Art by TOM FLOYD

The Curse of the Tree-Man inks by JOSEF RUBINSTEIN *& colors by* SCOTT BEACHLER

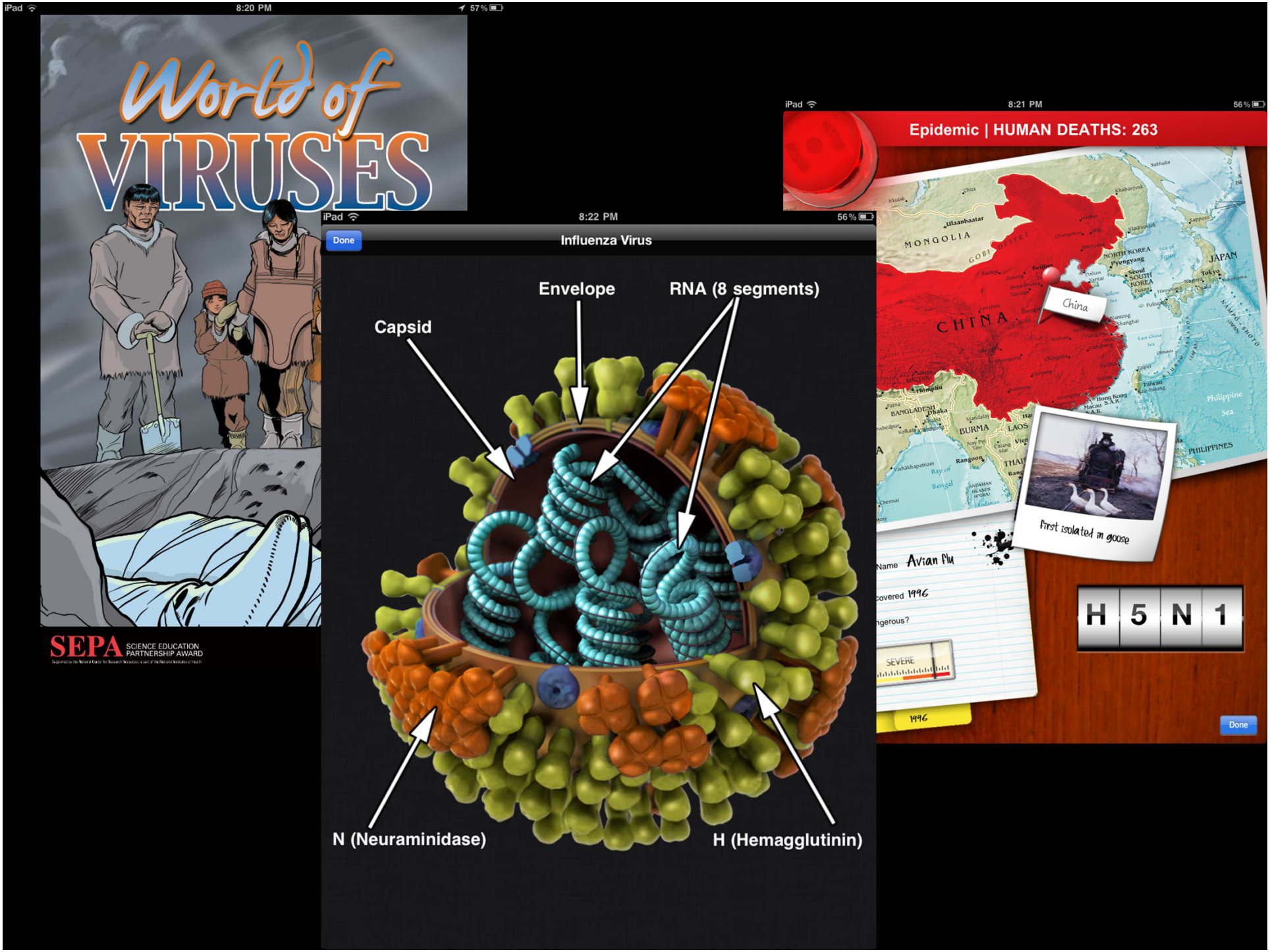
The Never-Ending Battle art by BRENT SCHOONOVER

Stories by MARTIN POWELL

Scientific illustration & production by ANGIE FOX

Essays by ANN DOWNER-HAZELL

Project Director JUDY DIAMOND


iPad
8:20 PM
57%
World of
VIRUSES
SEPA
SCIENCE EDUCATION
PARTNERSHIP AWARD
iPad
8:22 PM
56%
Done
Influenza Virus
Envelope
RNA (8 segments)
Capsid
N (Neuraminidase)
H (Hemagglutinin)
iPad
8:21 PM
56%
Epidemic | HUMAN DEATHS: 263
China
First isolated in goose
Name Avian Flu
covered 1996
SEVERE
1996
H 5 N 1
Done

World of Viruses Learning Research Team

Julia McQuillan Ph.D., Professor & Chair, Dept. Sociology,
University of Nebraska—Lincoln

Amy Spiegel Ph.D., Research Associate Professor
Center for Instructional Innovation, University of Nebraska—Lincoln

Camillia Matuk Ph.D., Assistant Professor of Educational Communication and Technology,
NYU Steinhardt School of Culture, Education and Human Development
MAGNET (Media and Games Network)

Peter Halpin, Assistant Professor of Applied Statistics, PRIISM Group at NYU Steinhardt

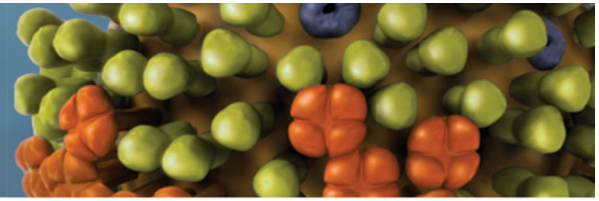
Bureau of Sociological Research (BOSR), University of Nebraska

Judy Diamond, Ph.D., Professor and Curator, University of Nebraska State Museum

Study of Science Identity and Engagement in High School Students

873 9th and 10th graders – students were randomly assigned to an essay or comic about a virus to assess whether students would engage and have more knowledge about viruses (Spiegel et al. 2013).

WAKING THE DEAD



by Ann Downer-Hazell

In remote places in Alaska, scientists armed with permits and shovels are venturing out onto the frozen tundra. Their mission: to wake the ghosts sleeping in the permafrost.

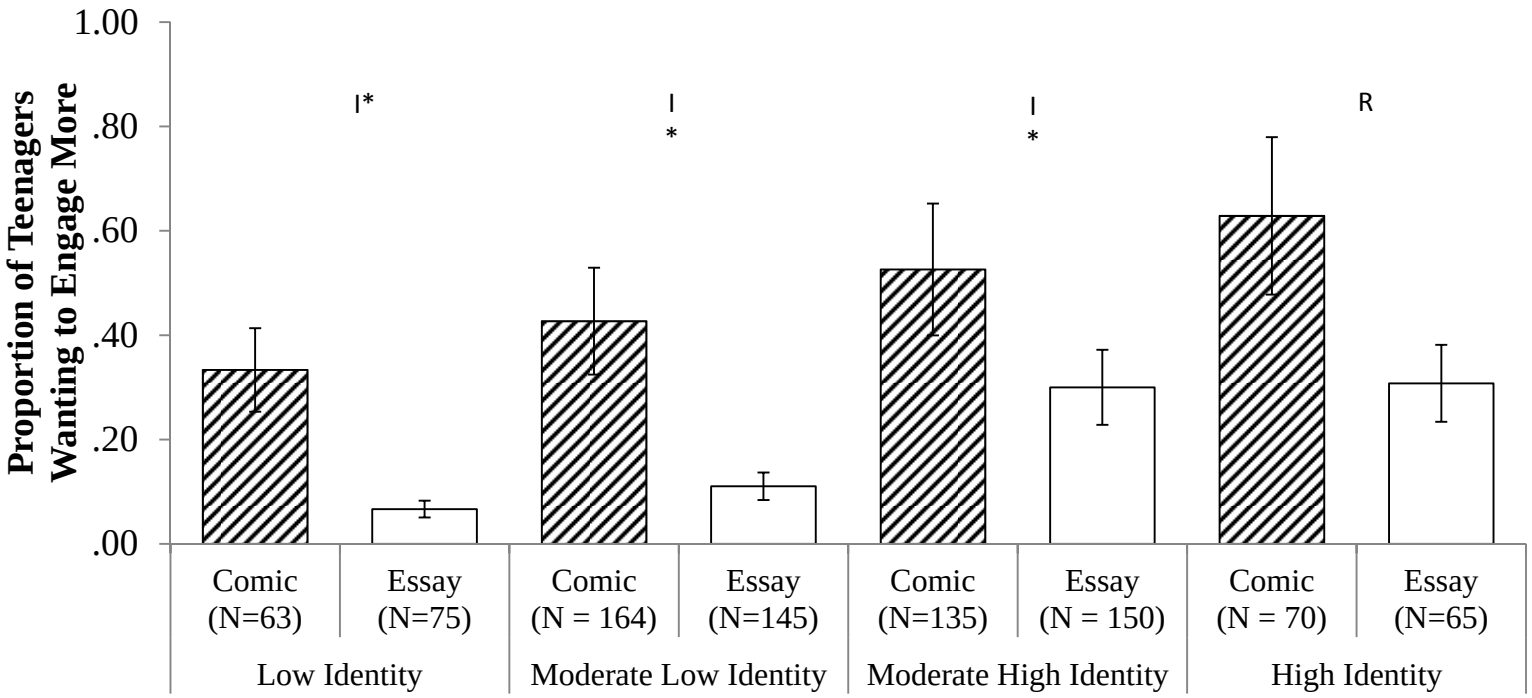
It's a long drive by Jeep to a place like Brevig Misson, Alaska. It's also a journey back in time. Almost one hundred years ago, the world was in the grip of a worldwide flu epidemic. In remote outposts like Brevig Mission, whole villages were wiped out in a matter of days by the deadly scourge. In some places, a cross is the only memorial left of entire communities—every man, woman, and child wiped out by one of the most deadly pathogens the world has ever known.

Scientists want to know how the tiny influenza virus manages to wreak such havoc. Over the last five years, pathologists—scientists who study the cause and effect of disease—have journeyed to the Arctic, back to villages along Alaska's Seward Peninsula, where almost a century ago flu raged unchecked. By exhuming the bodies of the epidemic's victims, pathologists hope to find traces of the 1918 virus in the frozen tissues. If the frozen ground has preserved the virus and its secrets well, scientists can use samples of infected tissue to culture the virus back in the lab. Then, by reading the virus's genetic fingerprint, they hope to identify the strain responsible for the 1918 outbreak.

Influenza is a shape-shifter. Virologists think the strain of flu responsible for the 1918 pandemic may have started out in another species—influenza lives happily in other animals, including pigs and birds. When people first domesticated ducks, chickens, geese, and pigs, they began to live alongside them, giving the viral shape-shifter a chance to mingle and adapt. New strains of flu arise when the virus has a chance to exchange genes with other viruses already at home in an animal host in a process called reassortment. Some time before the 1918 outbreak, the influenza virus acquired the genes it needed to shape-shift and jump from its animal host to a new, human one.

In a remote Alaskan village in 1918, the flu would have spread quickly. Death would have been quick, cruel, and brutal, leaving few survivors to bury the dead and tell how the disaster had unfolded. Today researchers are looking to the dead to tell the story of this flu mystery. By analyzing frozen tissue samples from the 1918 victims, researchers hope to crack the virus's genetic code and understand what made the 1918 strain so very deadly. They hope to use that knowledge to design a more effective vaccine to protect against a future outbreak.

To the ancient Greeks, a chimera was a fantastic monster, part lion, part snake, part goat. To scientists, influenza is a different kind of chimera—part virus, part pig, part bird. Will flu stay one step ahead of us, ever changing? Who will write the last chapter in this frozen medical mystery?



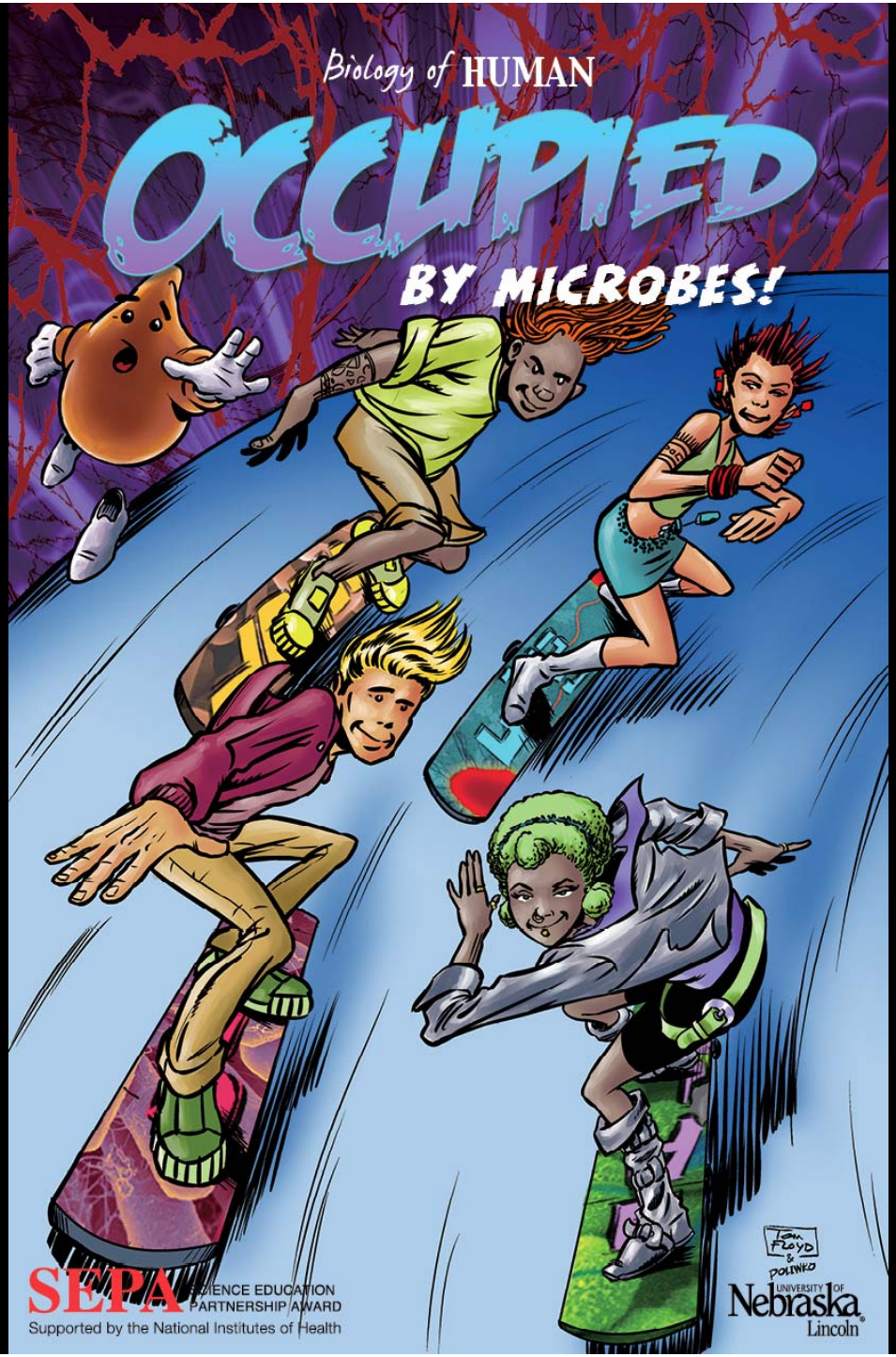
I* = p < .05 Significant Interaction for the difference between comic and essay compared to the reference (R) categc high identity. Error bars represent 95% confidence interval.

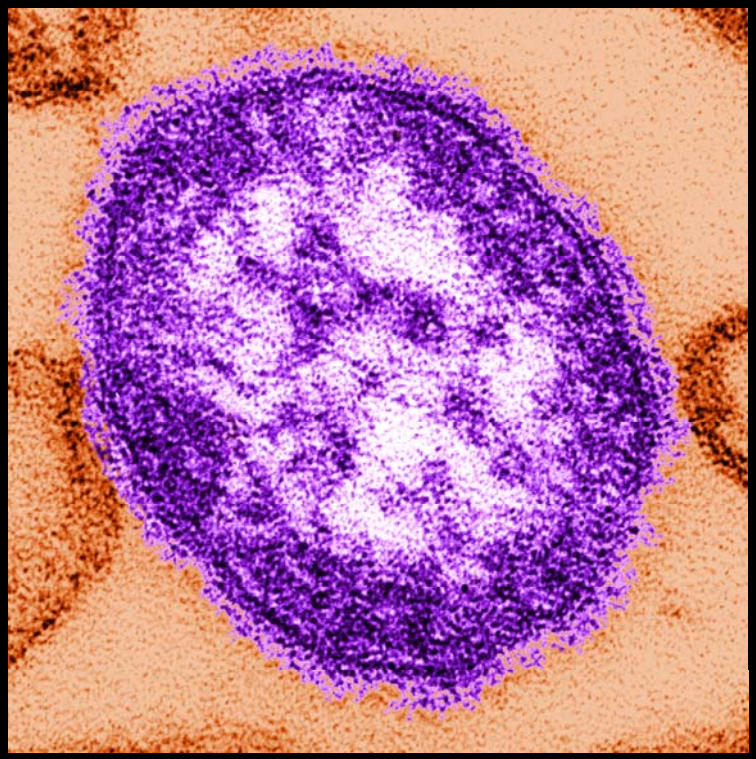
- Teenagers across all comic groups were more likely to want to read additional materials than those in the essay groups
- Odds ratio between comic and essay conditions is largest for those in low science identity group
- No difference between comic and essay groups on knowledge

- Indicators of science identity were:
  - General interest in science
  - Science grades
  - Likert ratings on “People in my life think of me as a science person,” “I have always liked science,” & “I’m just not a science person (reverse coded).”
- Results of LCA grouped individuals into four latent classes along a continuum from high to low science identity.
- We then used latent classes to measure interaction of science identity with comic vs. essay.

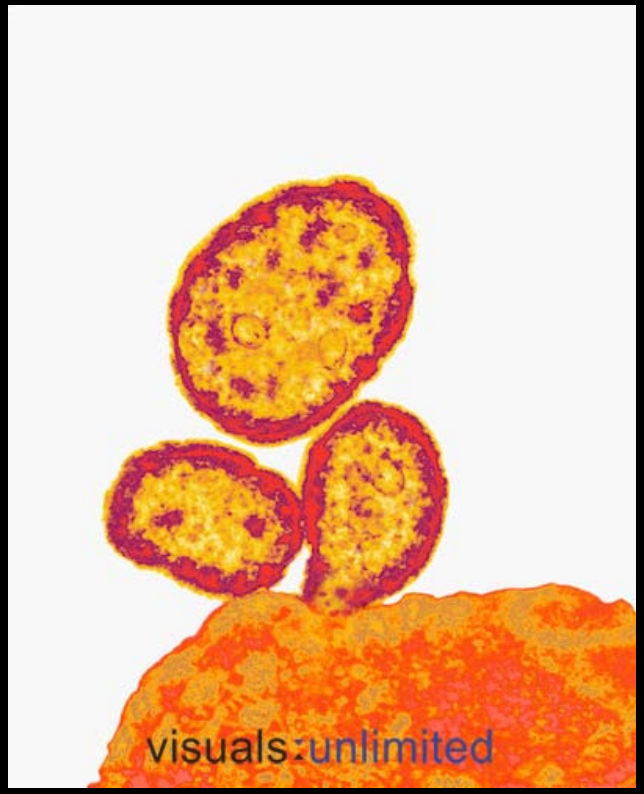
There were no differences in content knowledge about viruses for teenagers exposed to comic versus those who read the essays. However, those who read the comics were more motivated to read additional materials.

Spiegel, A.N., McQuillan, J., Halpin, P., Matuk, C., & Diamond, J. (2013). Engaging Teenagers with Science through Comics, *Research in Science Education, 43*(6), 2309-2326.


Biology of HUMAN
OCCUPIED
BY MICROBES!
SEPA
SCIENCE EDUCATION PARTNERSHIP AWARD
Supported by the National Institutes of Health
TOM FLOYD & POLIWKO
University of Nebraska Lincoln



Measles & Vaccines



Biology of Human / World of Viruses

http://biologyofhuman.unl.edu

The *Biology of Human* project was funded by the National Institutes of Health (NIH) through the Science Education Partnership Award (SEPA) Grant No. R25OD010506. Its content is solely the responsibility of the authors and does not necessarily represent the official views of the NIH. Principal investigators are Judy Diamond Ph.D., University of Nebraska State Museum, Julia McQuillan Ph.D., Department of Sociology at the University of Nebraska (UNL), and Charles Wood Ph.D., the Nebraska Center for Virology.

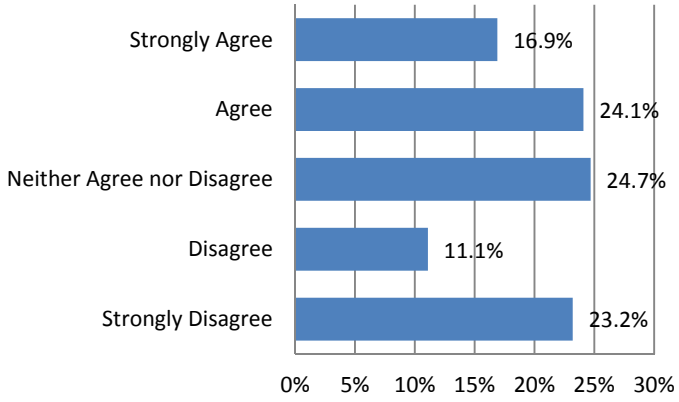
Latent Class Analysis (LCA)

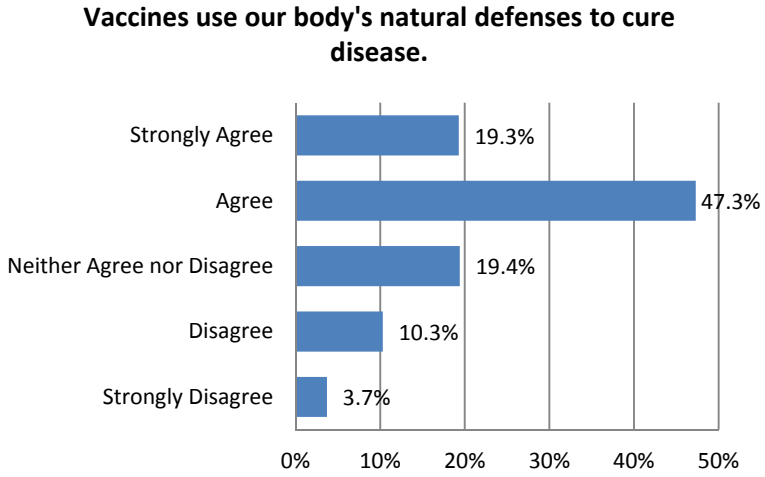
- LCA assumes the existence of an underlying construct, in this case, science identity.
- The method sorts a large number of individuals into a small number of groups using multivariate, categorical data.
- Model parameters are estimated using Maximum Likelihood, and the fit of the model determines the number of categories.
- Our study included 873 high school youth enrolled in a required ninth or tenth grade biology class.
- We examined differences in students' interest in engaging with materials about viruses: comic vs. traditional essay.

- **Innovative educational approaches**
- **Understanding your your audience**
- **Impact research**
- **Partnerships**

2012 NIH SEPA Proposal Narrative

Results from 2011 Nebraska Annual Statewide Survey (NASIS) of 679 adult Nebraskans on three questions assessing degree of acceptance of biomedical concepts.





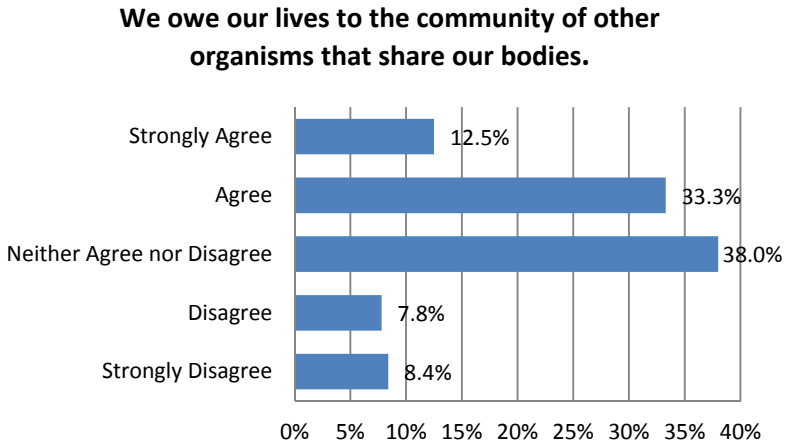
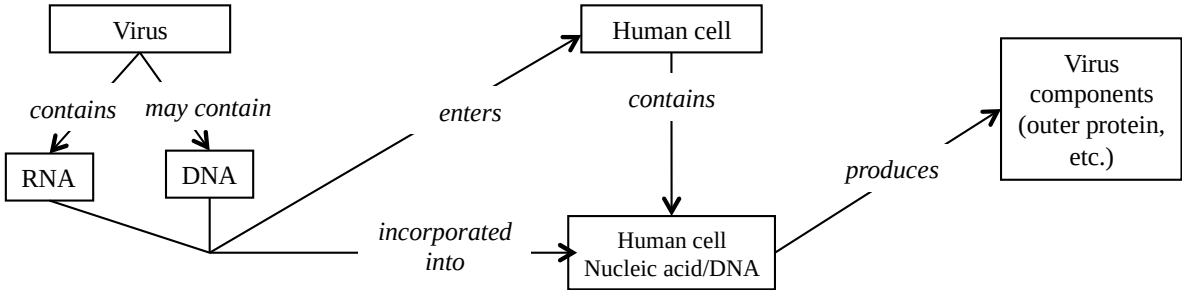
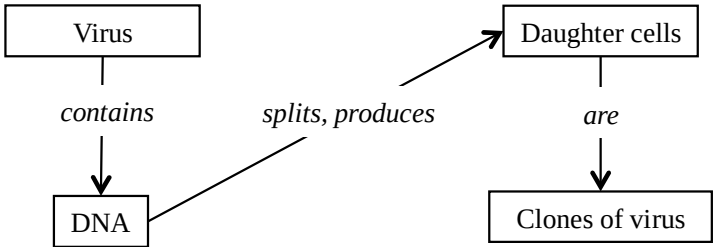


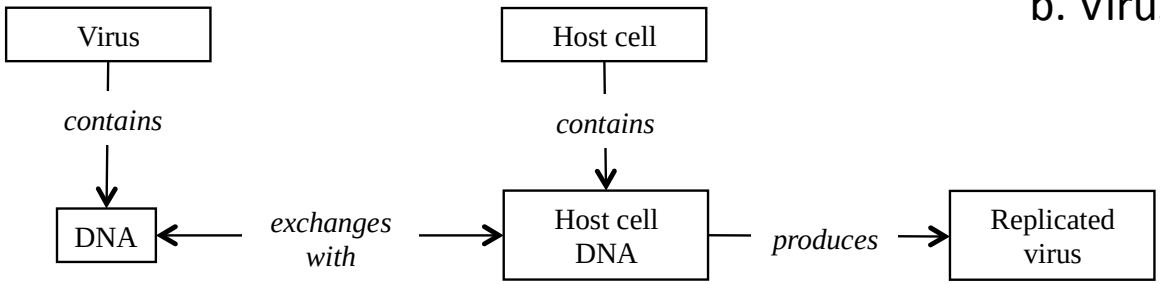
Figure 1. Mental models of virus replication (virologists, teachers, students).



a. Virus uses host nucleic acid model



b. Virus cell division model



c. Less specific version of virus uses host nucleic acid model

surveys (e.g. NASIS)

randomized control trials

observations

interviews

experiments

pre-post measures

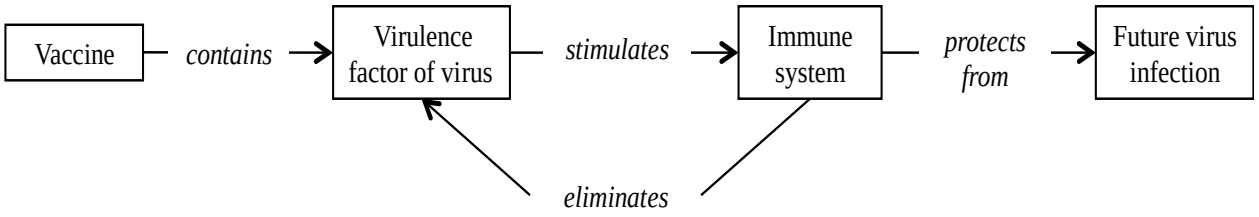
participant observation

expert review

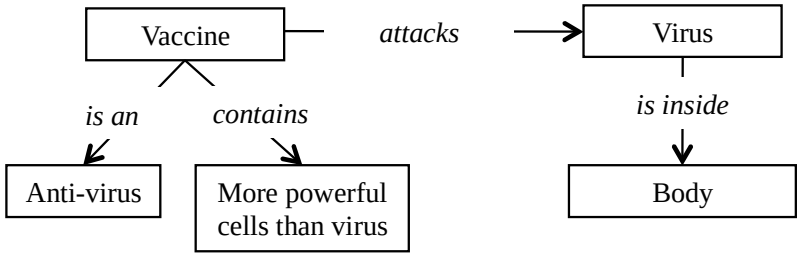
clinical interviews

cognitive scientists
sociologists
survey researchers
developmental psychologists
human factors researchers

Figure 2. Mental models of vaccines.



a. Vaccine stimulates immune system model



b. Antivirus model

Jee, B., Uttal, D., Spiegel, A. and Diamond, J. 2013. Mental models of viruses, vaccines, and the causes of infectious disease. *Public Understanding of Science* doi: 10.1177/0963662513496954.

caise: center for advancement of informal science education

http://informalscience.org

World of Viruses/ Biology of Human

Judy Diamond, Ph.D., Professor and Curator, University of Nebraska State Museum

Julia McQuillan Ph.D., Professor & Chair, Dept. Sociology,
University of Nebraska—Lincoln

Amy Spiegel Ph.D., Research Associate Professor
Center for Instructional Innovation, University of Nebraska—Lincoln

Patricia Wonch Hill Ph.D., Research Assistant Professor, Dept. Sociology
University of Nebraska—Lincoln

Camillia Matuk Ph.D., Assistant Professor of Educational Communication and Technology,
NYU Steinhardt School of Culture, Education and Human Development
MAGNET (Media and Games Network)

Peter Halpin, Assistant Professor of Applied Statistics, PRIISM Group at NYU Steinhardt